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**Pollen characters of Old World Gesneriaceae
(Cyrtandroideae).**

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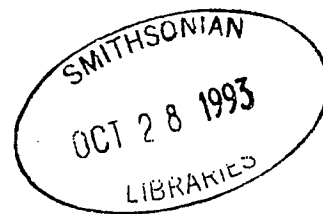
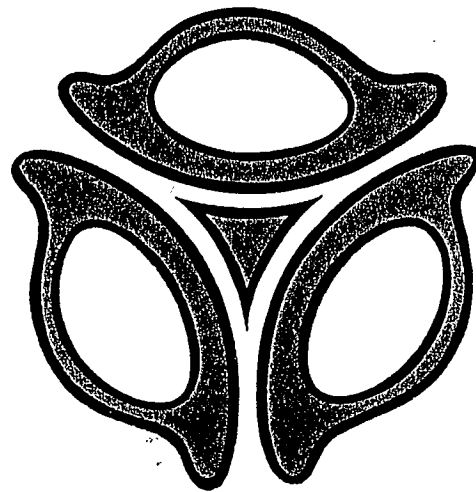
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Pollen characters of Old World Gesneriaceae (Cyrtandroideae)

With special reference to SE Asian taxa

EVA LUEGMAYR

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Pollen of 108 species out of 18 genera (from all tribes of the Old World Gesneriaceae [subf. Cyrtandroideae]) was examined using light, scanning and transmission electron microscopy. The pollen grains are small sized, isopolar and 3-colpate or 3-colporate. In equatorial view they are mostly spheroidal (rarely suboblate or oblate), in polar view circular or subangular. The most variable character is the exine structure and -sculpture. The tectum is perforate, microreticulate, coarsely reticulate or rugulate. Further important characters of the tectum are (a) the presence or absence of conical supratectate sculptural elements, and (b) the width of lumina being either equal or exhibiting different at the apo- and mesocolpium. Ten exine types are distinguished. Some genera and species can be well referred to a special exine type, e.g., *Aeschynanthus*, *Epithema*, *Stauranthera grandiflora*; in other genera several exine types occur, e.g., in the large and heterogeneous genus *Didymocarpus*. The pollen morphology of the two large subfamilies Cyrtandroideae and Gesnerioideae is compared.

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The mainly tropical and subtropical family Gesneriaceae (comprising about 3.000 species) poses problems at all levels of classification.

Increasing knowledge in the last decades has cast doubt on the traditional system of Fritsch (1893) who divided the family into 2 subfamilies: (a) the Cyrtandroideae with a superior ovary, and (b) the Gesnerioideae with a \pm inferior ovary. Burt (1963) considered the cotyledons being a more important taxonomic character. He newly defined and delimited the Cyrtandroideae as having seedlings with unequal cotyledons (anisocotily) and the Gesnerioideae having equal cotyledons. Burt's classification matches well with the geographical distribution: The Cyrtandroideae include (with the only exception of some species of *Rhynchoglossum*) the Old World Gesneriaceae, while the Gesnerioideae are exclusively distributed in the New World. Burt (1963) also remodelled drastically the tribal classification and the placement of various genera. Recently, Wiehler (1983) established a third subfamily, the Coronantheroideae with austral distribution. Information about pollen morphology of the Gesneriaceae is still scarce and its bearing on the infrafamilial classification is little known. Some pollen data of the family can be gathered from a brief survey by Erdtman (1952) and an unpublished investigation (Abstract) by Woods (1964), both using the light microscope. Modern SEM-studies (Skog 1976, Williams 1978, Fritze & Williams 1988) exclusively deal with genera of the subfam. Gesnerioideae. Fritze & Williams (1988) found a wide variety of pollen forms and drew attention to its taxonomic significance. The present investigation is de-

voted to the subfam. Cyrtandroideae. It specially concentrates on Malayan taxa, but includes also some species of the large African genus *Streptocarpus*. The present paper gives a general survey of the pollen morphology and points out the differences to the New World Gesneriaceae. Detailed pollen descriptions of the particular genera and an extensive consideration of the taxonomic implications will be presented in a forthcoming paper.

MATERIAL AND METHODS

Pollen samples were taken either from herbarium specimens (WU, L) or from living plants grown in the greenhouses at the Botanical Garden (HBV) of the University of Vienna. Anthers were preserved in 70% alcohol or glutaraldehyde. 108 species out of 18 genera (from all tribes of the subfamily) have been studied.

For LM-investigation preserved or fresh pollen was mounted in glycerine jelly according to Wodehouse (1935). For SEM-investigation, anthers of herbarized flowers were soaked in a 10% aqueous mixture of dioctyl sodium sulfosuccinat and 95% acetone for 24 hours (Peterson et al. 1978). By that treatment the pollen grains expand and are better comparable with fresh grains. Soaked and preserved anthers were first dehydrated in an alcohol series, subsequently chemically dehydrated in FDA (formaldehyde-dimethyl-acetal, Gerstenberger & Leins 1978) and then critical-point-dried. A few samples were acetolyzed following the method of Erdtman (1960). A comparison of critical-point-dried and acetolyzed material revealed that both treatments give good results. A significant increase of pollen size effected by acetolysis (Reitsma 1969, Albers & Pambor 1984) was not observed. The dry pollen grains were placed on aluminium specimen stubs and sputter-coated with gold. For TEM-investigation, preserved anthers were dehydrated in an ethanol series and embedded in Spurr's mixture (Spurr 1969). The

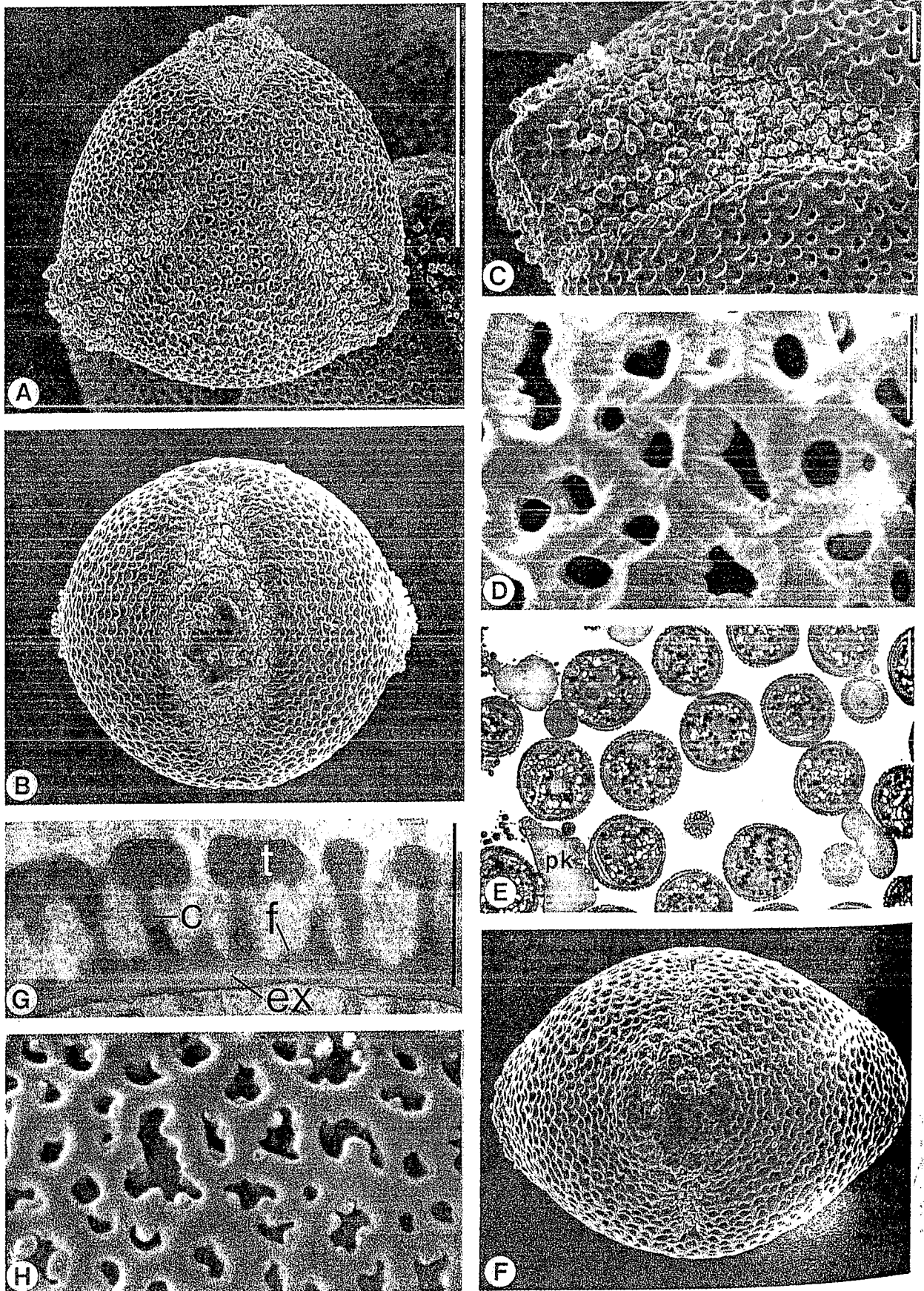


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ultrathin sections were contrasted with uranyl acetate and lead citrate. Semithin sections were stained with toluidin blue and examined with the light microscope.

Pollen terminology follows Erdtman (1969), Faegri & Iversen (1975) and Pragłowski & Punt (1973).

RESULTS

General pollen description

The grains are 3-colpate or 3-colporate (very rarely 4-colpate/colporate), spheroidal to oblate in equatorial view, circular to angular in polar view. Average pollen grain diameter: 9–24 μm (= E).

Apertures. – Long and \pm tapering, endexinous colpus membrane often covered with ectexinous granular elements (Figs. 1C, 2C), rarely smooth (Fig. 6D). **Exine pattern.** – Reticulate (Figs. 1–4), perforate (Fig. 5) or rugulate (Fig. 6); supratectate sculptural elements present or absent. Sexine 3–4 \times thicker than nexine (Figs. 4F, 5D). Tectum (thickness c. 0.3 μm) up to 3 \times thicker than foot layer. Columellae often higher or at least as high as tectum thickness (Fig. 1G). Lamellated endexine mostly thin at the mesocolpia, but increasing in thickness at the aperture region, forming a colpus membrane. Intine 2-layered; exintine thickened at aperture region with radially oriented channels (Fig. 4G).

Exine types

The character of greatest variability (and, therefore, of greatest taxonomic interest) is the exine pattern. With regard to the tectum three main types can be distinguished: (1) reticulate, (2) perforate, (3) rugulate. Further important characters of the tectum are (a) the presence or absence of conical supratectate sculptural elements, and (b) the width of lumina being either equal or exhibiting differently at the apo- and mesocolpia. The following exine types, differing in structure and sculpture, can be distinguished:

Type 1. – Tectum reticulate-microreticulate; width of the lumina \pm equal at the apo- and mesocolpia; supratectate sculptural elements absent; lumina irregular, luminal processes lacking (Fig. 1A–D). In *Monophyllaea* there are conspicuous minute sinuses at the side surfaces of the muri (Fig. 1H).

Type 2. – Mesocolpia reticulate proceeding to perforate at

the polar region (apocolpia perforate); lumina at the mesocolpia conspicuously irregular, supratectate sculptural elements absent; occasionally rod-like luminal processes present (Fig. 2A–E).

Type 3. – Apo- and mesocolpia reticulate; lumina at the polar region markedly larger and more irregular, supratectate sculptural elements absent; occasionally rod-like luminal processes present (Fig. 2F–G).

Type 4. – Apo- and mesocolpia coarsely reticulate with numerous rod-like luminal processes; supratectate sculptural elements absent (Fig. 3A–D).

Type 5. – Mesocolpia coarsely reticulate, numerous rod-like luminal processes present, width of lumina grading to perforate at the polar region (apocolpia perforate); supratectate sculptural elements absent (Fig. 3E).

Type 6. – Apo- and mesocolpia microreticulate; numerous conical supratectate sculptural elements present; lumina circular to elliptic (Fig. 4A–C).

Type 7. – Apo- and mesocolpia microreticulate; numerous conical supratectate sculptural elements present; lumina irregular, occasionally rod-like luminal processes present (Fig. 4D–I).

Type 8. – Apo- and mesocolpia perforate; supratectate sculpturing elements absent (Fig. 5A–C).

Type 9. – Apo- and mesocolpia perforate, numerous conical-scabrate supratectate sculpturing elements present (Fig. 5D–I).

Type 10. – Apo- and mesocolpia rugulate (Fig. 6A–E).

Pollen grain shape

The grains are generally spheroidal with a circular outline in polar and equatorial view (Fig. 1A–B); only in *Epithema* (Fig. 6A–C) and *Monophyllaea* (Fig. 1F) the pollen grains differ in shape: they are suboblate-oblate with a semi-angular-angular outline in polar view.

Apertures

The pollen grains are basically tricolpate or tricolporate, but in a few species (*Didymocarpus hispidus*, *Epithema membranaceum*, *Cyrtandra clarkei*) a small percentage of tetracolpate grains has been observed. The long colpi (definition of aperture length cf. Fritze & Williams 1988) are closed by an endexinous colpus membrane which is generally studded with ectexinous granular elements (Figs. 1C, 2C, 5C). Only in *Epithema* such granular elements are lacking and the colpus membrane is smooth (Fig. 6D).

Fig. 1. LM-, SEM- and TEM-micrographs of unacetolyzed pollen grains, showing exine Type 1. A–C. *Streptocarpus orientalis*. (A) Polar view; SEM. (B) Equatorial view; SEM. (C) Part of aperture, note ectexinous granular elements; SEM. D. *Didymocarpus longipes*. Detail of mesocolpium; SEM. E–G. *Monophyllaea horsfieldii*. (E) Semithin section of pollen grains after first pollen mitosis, *pk* = pollenkit; LM. (F) Equatorial view, note oblate pollen shape; SEM. (G) Section through exine of a young pollen grain, showing ectexine with tectum (*t*), long columellae (*c*), a thin, discontinuous foot-layer (*f*) and lamellated endexine (*ex*), intine is still absent; TEM. H. *M. hirticalyx*. Detail of mesocolpium, note conspicuous minute sinuses at the side surfaces of the muri; SEM. Scale bars: 10 μm (A and B and E, F, G); 1 μm (C, D, and H, G).

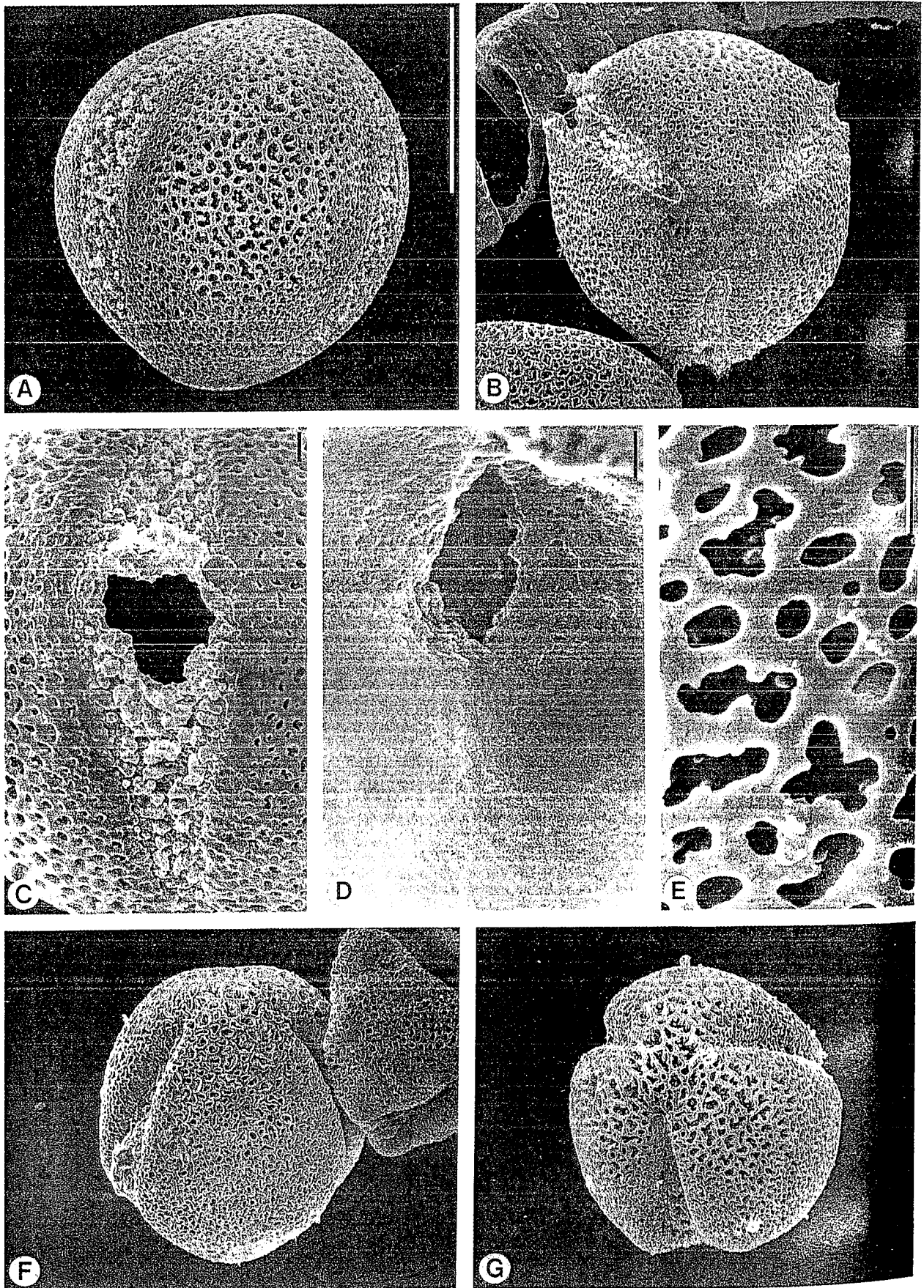


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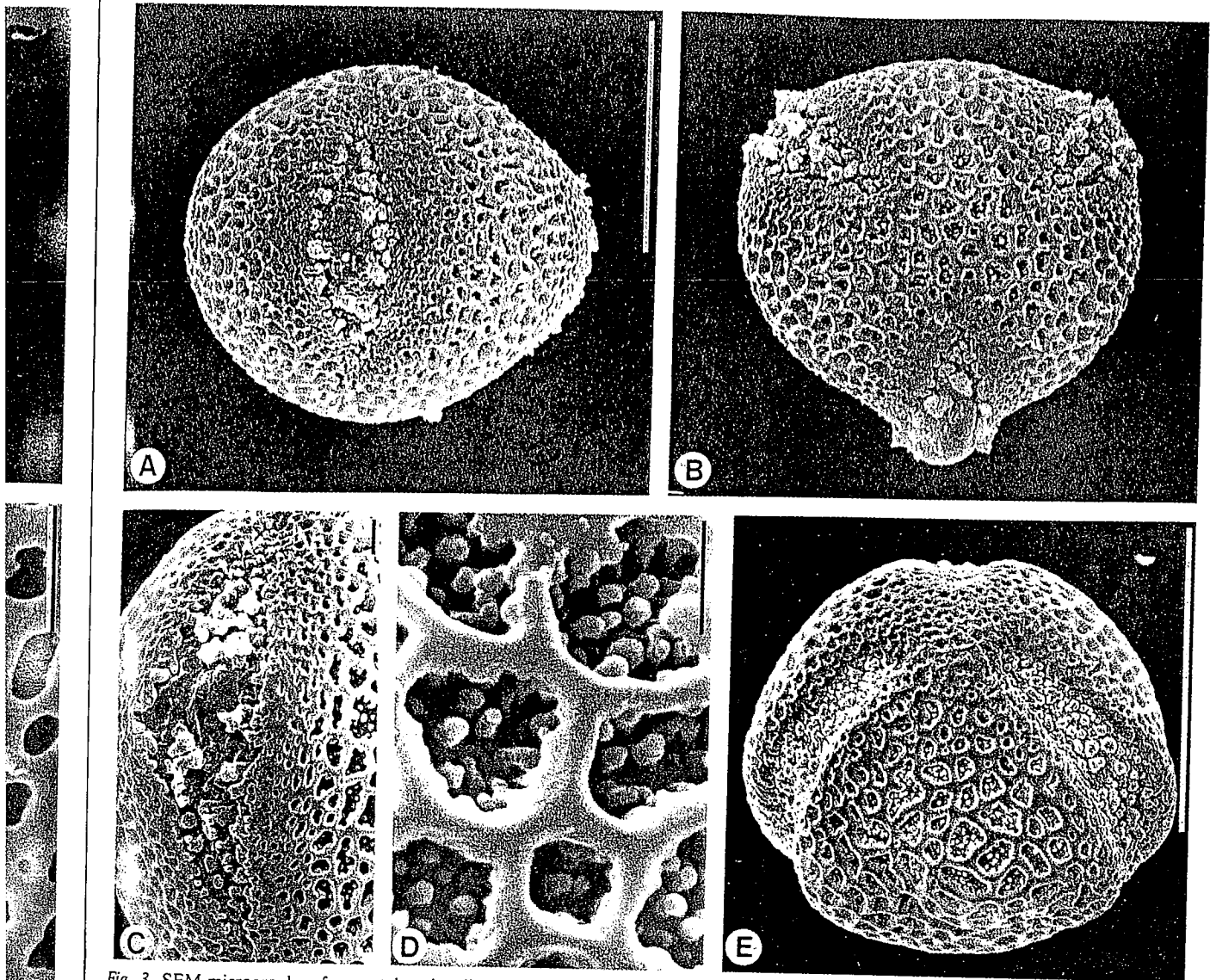


Fig. 3. SEM-micrographs of unacetolyzed pollen grains showing exine Type 4 (A–D) and 5 (E). A–D. *Stauranthera grandiflora*. (A) Equatorial view. (B) Polar view, note coarsely reticulate apocolpium. (C) Aperture and adjacent parts of mesocolpium, showing large lumina and numerous rod-like luminal processes. (D) Detail of mesocolpium, showing large lumina and numerous rod-like luminal processes. E. *Streptocarpus silvaticus*. Oblique equatorial view, note large, irregular lumina at the mesocolpium and the perforate apocolpium. – Scale bars: 10 μm (A and B, E), 1 μm (C, D).

DISCUSSION

The subfamily Cyrtandroideae is eurypalynous. The most distinctive characters are provided by the exine structure and sculpture. These features may be of use at the generic, subgeneric and/or specific level. Some genera such as *Aeschynanthus*, *Chirita* and *Epithema* are stenopalynous and easily distinguishable from other genera because of the

characteristic exine patterns (*Aeschynanthus*: Type 2, *Chirita*: Type 6, *Epithema*: Type 10). For these taxa the pollen appears to be of taxonomic relevance at the generic level. However, more species should be examined for confirmation. In particular, from the large and morphological heterogeneous genus *Chirita* (Wood 1974) only pollen material of species of one section (sect. *Microchirita*) was available for investigation; therefore, the characterization of the

Fig. 2. SEM-micrographs of unacetolyzed (A, F–G) and acetolyzed (B–E) pollen grains, showing exine Type 2 (A–E) and 3 (F–G). A. *Aeschynanthus boschianus*. Equatorial view. B–E. *A. parvifolius*. (B) Polar view, note perforate apocolpium. (C) Colporate aperture, showing \pm irregular porus and endexinous aperture membrane beset with isolated ectexinous elements. (D) Fractured pollen grain, showing interior view of a colporate aperture, note porus and endosculpturing. (E) Detail of mesocolpium. F–G. *Didissandra morgani*. (F) Equatorial view. (G) Oblique polar view, note large and conspicuous irregular lumina at the apocolpium. – Scale bars: 10 μm (A and B and F and G), 1 μm (C, D, E).

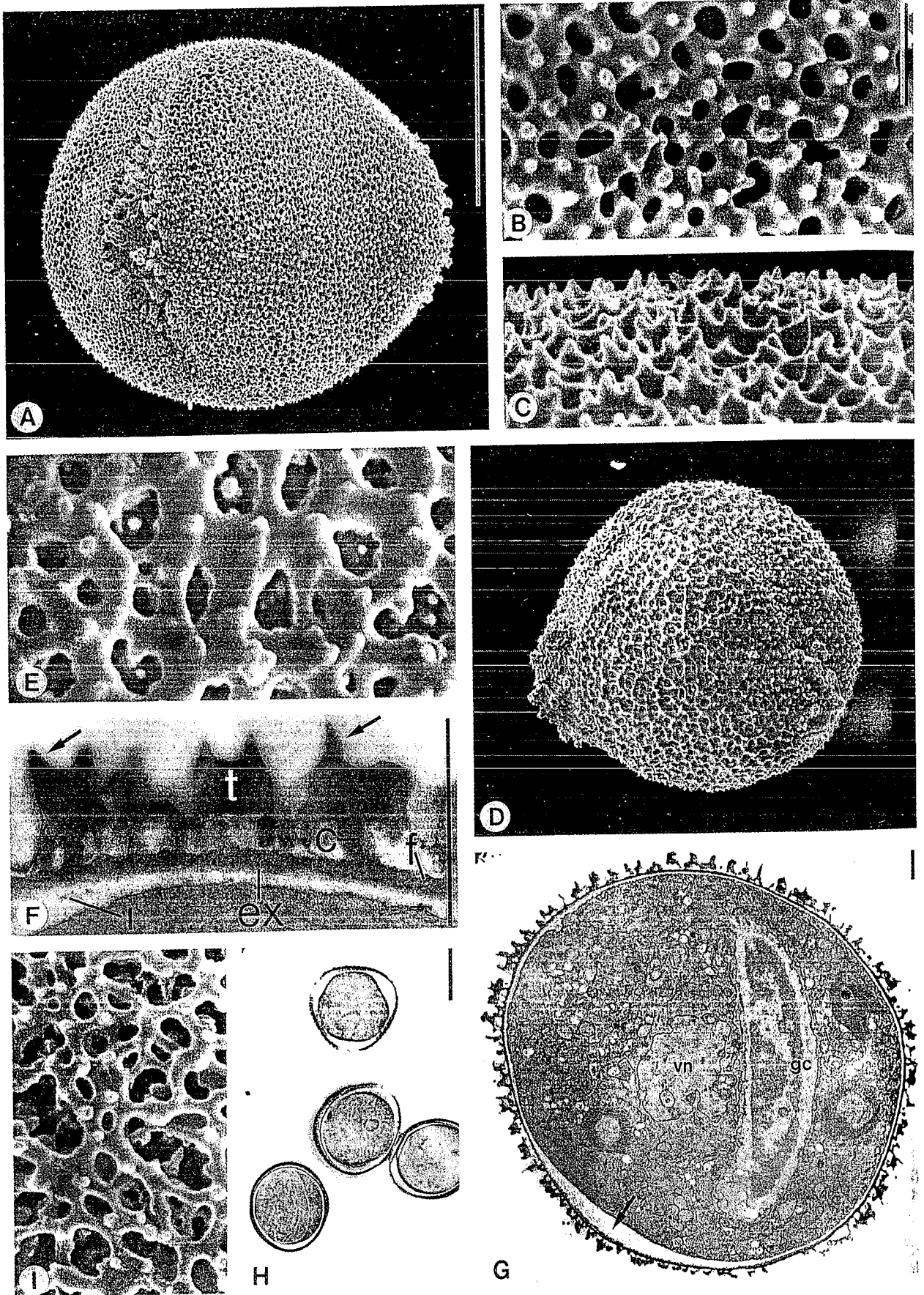


Fig. 4.
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genus as stenopalynous must be regarded as very tentative. Other genera, especially large and taxonomically problematic ones such as *Cyrtandra*, *Didissandra*, *Didymocarpus*, *Paraboea* and *Streptocarpus* are eurypalynous, with various exine pattern being discernible within each genus. In these cases the pollen structure partly supports the subgeneric classification (at least in *Didissandra*, *Didymocarpus* and *Streptocarpus*) or may give new clues for a better recognition of species alliances. Apparently allied genera such as *Boea*, *Paraboea*, *Trisepalum* and *Boeica* (Burt 1984) share a similar pollen spectrum, thus the close relationship of these genera is supported by the pollen morphology too. The same applies to the genera *Didymocarpus*, *Loxocarpus* and *Codonoboea*. Certain exine types have so far been found only in single taxa and make them palynologically well recognizable (e.g., Type 4 in *Stauranthera grandiflora*, Type 5 in *Streptocarpus silvaticus*). Apart from the exine pattern the pollen shape and aperture form display some variation. Pollen size, however, does not appear taxonomically significant. The smallest grains occur in *Didymocarpus cordatus* ($E = 9 \mu\text{m}$), the largest in *Loxocarpus coeruleus* ($E = 24 \mu\text{m}$). Because of the very small size of the grains the differences in the exine can be only clearly observed in the SEM. This is probably an important reason for the fact, that the pollen morphology of the subfam. Cyrtandroideae has attracted little interest so far. However, Woods (1964) already pointed out that a distinction between pollen of the subfam. Cyrtandroideae and Gesnerioideae is frequently possible. She found homobrochate exines to be typical for the Cyrtandroideae and heterobrochate exines to be prevalent in the Gesnerioideae. She also noticed a difference in size: the Gesnerioideae tend to have larger pollen grains.

As now SEM-data are available both for New World (Williams 1978, Fritze & Williams 1988) and Old World Gesneriaceae, the two subfamilies as defined by Burt (1963) can be better contrasted palynologically. Principally, the pollen grains of the Gesneriaceae are monads, isopolar and tricolpate or tricolporate; the exine structure consists of a tectum, columellae and a foot layer. With regard to the two subfamilies, a difference in pollen size is indeed observable (Gesnerioideae $E = 26\text{--}51 \mu\text{m}$, Cyrtandroideae $E = 9\text{--}24 \mu\text{m}$). However, in both subfamilies there is no relation between pollen size and pollen type. A distinctive character is the length of the apertures. In the Gesnerioideae long, intermediate and short apertures can be distinguished (Fritze & Williams 1988). In contrast,

variation in aperture length was not found in the Cyrtandroideae examined – the colpi are always long.

In both subfamilies the exine provides important diagnostic characters. The reticulate exine pattern is the most widespread and variable feature in the Gesneriaceae. Perforate exines are also common in the family, but a rugulate pattern was so far only recorded in a single genus of the Cyrtandroideae (*Epithema*, Fig. 6). Supratectate sculptural elements are frequent in the Cyrtandroideae, but seem to lack in the Gesnerioideae.

Homobrochate and heterobrochate reticula can be found in both subfamilies, but the heterobrochate pattern is different: In the Gesnerioideae the muri of the reticulum are pierced by numerous small, very evenly distributed perforations (Fig. 7B); in the Cyrtandroideae such small perforations are less frequent and irregularly arranged (Figs. 1H, 2E, 7D). Homobrochate exines (in the sense of Erdtman 1952) are widespread in the Cyrtandroideae (Figs. 1A, 4A, 4B), but are rarely found in the Gesnerioideae (cf. Woods 1964). A conspicuous distinctive feature can be observed in pollen grains exhibiting markedly different lumina widths at the apo- and mesocolpia. Typical for the Gesnerioideae is an abrupt decrease of lumina width from the central mesocolpium towards the colpi and the poles. Thus a \pm sharp demarcation line can be drawn between the perforate and the reticulate region (Fig. 7A). In contrast, in the Cyrtandroideae the lumina width always decreases very gradually and no demarcation line can be drawn (Fig. 7C).

Though the pollen morphology provides significant distinctive features and may contribute to a better definition of the two subfamilies, the field of overlap must not be ignored. In addition, a large proportion of gesneriaceous genera (including those accommodated in Wiehler's third subfamily Coronantherioideae) has not yet been investigated.

TAXA INVESTIGATED

Taxa without quotation of origin were collected in peninsular Malaysia.

u.o. = unknown origin.

Aeschynanthus

A. albidus (Bl.) Steud.: GS 90/5 (cult. HBV, WU). *A. boschianus* de Vriese: GS 90/7 (cult. HBV). *A. ellipticus*

Fig. 4. LM-, SEM- and TEM-micrographs of unacetolyzed pollen grains showing exine Type 6 (A–C) and 7 (D–I). A. *Chirita caliginosa*. Equatorial view; SEM. B–C. *C. lavandulacea*. (B) Detail of mesocolpium; SEM. (C) Side view of conical supratectate elements; SEM. D–E. *Didymocarpus* aff. *floribundus*. (D) Oblique equatorial view; SEM. (E) Detail of mesocolpium; SEM. F–H. *Cyrtandra pendula*. (F) Ultrathin section of exine, showing ectexine with conical supratectate elements (arrows), tectum (t), columellae (c), foot-layer (f), endexine (ex) and intine (i); TEM. (G) Ultrathin section of a mature pollen grain, showing intine thickening at aperture region (arrow), vegetative nucleus (vn) and generative cell (gc); TEM. (H) Pollen grains in polar and equatorial view; LM. I. *C. pilosa*. Detail of mesocolpium; SEM. – Scale bars: 10 μm (A and D, H), 1 μm (B and C and E and I, F, G).

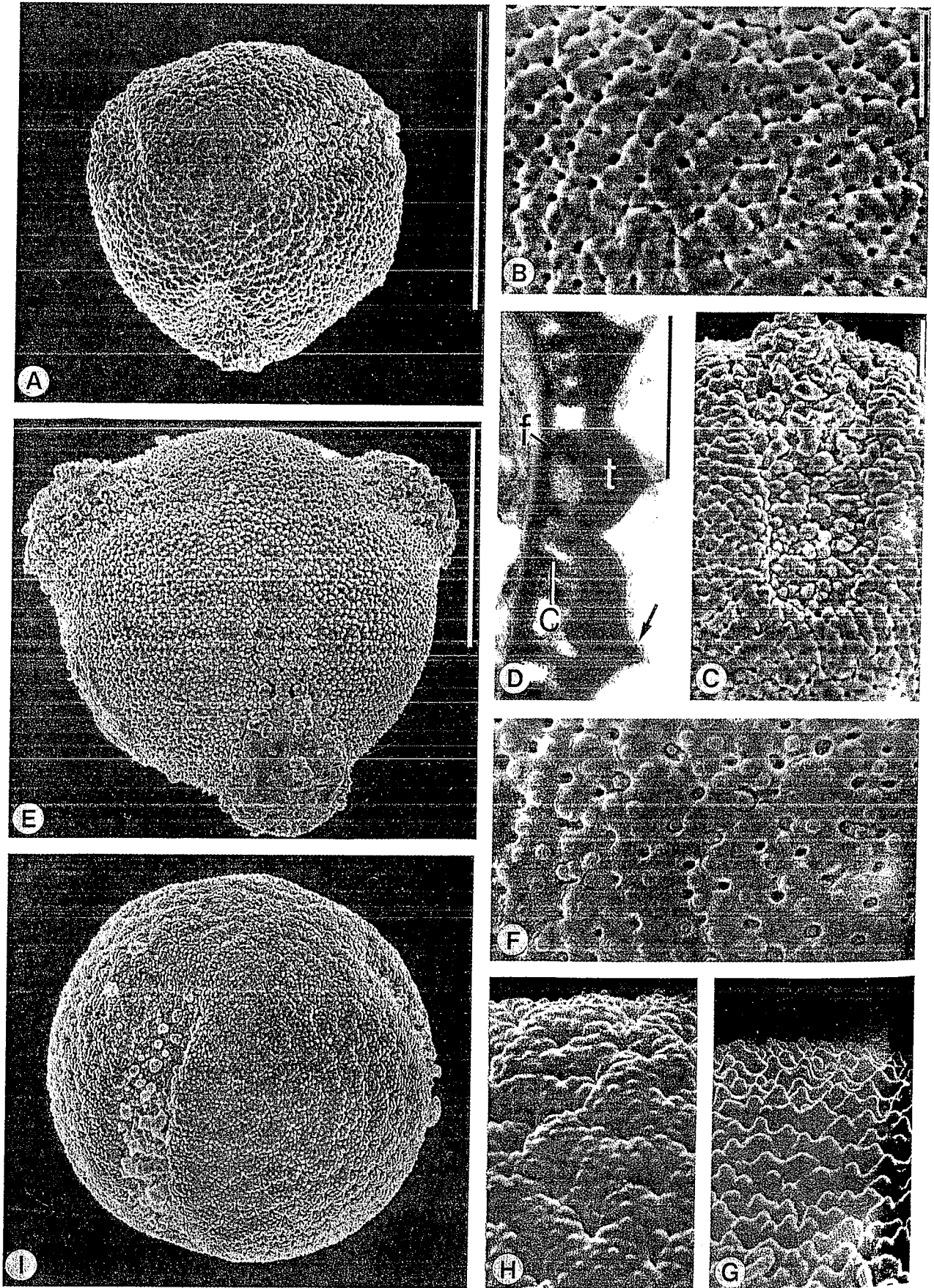


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Lauterb. & Schum. NEW GUINEA: 030983 (WU). *A. longicalyx* Ridl. var. *superbus* Ridl.: Vogel & Weber 790905 (WU). *A. hildebrandii* Hensl. THAILAND: HK 474 (cult. HBV, WU). *A. myrmecophilus* P. Woods: Vogel & Weber 790820-1/1 (WU). *A. obonicus* C. B. Cl.: Weber 840814-4/1 (WU). *A. parvifolius* R. Br.: Weber 840810-3/3 (WU). *A. pulcher* (Bl.) G. Don: GS 90/14 (cult. HBV, WU). *A. radicans* Jack: Weber 860813-1/5 (WU). *A. rhododendron* Ridl.: Vogel & Weber 790822-1/5 (WU). *A. tricolor* Hook.: GS 90/22 (cult. HBV, WU). *A. wallichii* R. Br.: Weber 840722-2/1 (WU).

Boea

B. hygrometrica (Bunge) R. Br. CHINA: s.n. (cult. HBV). *B. lawesii* H. O. Forbes, NEW GUINEA: s.n. (cult. HBV, WU).

Boeica

B. brachyandra Ridl.: Weber & Stone 870426-1/10 (cult. HBV, WU).

Chirita

C. bimaculata D. Wood: GS 91/5 (cult. HBV, WU). *C. caliginosa* C. B. Cl.: Vogel & Weber 790729 (WU). *C. hamosa* R. Br.: u.o., s.n. (cult. HBV). *C. involucreta* Craib. THAILAND: Kurzweil HK 709 (WU). *C. lacunosa* (Hook. f.) B. L. Burtt: GS 3/87 (cult. HBV). *C. lavandulacea* Stapf: u.o., s.n. (cult. HBV, WU). *C. cf. sericea* Ridl.: Weber 860818-1/1 (cult. HBV, WU).

Codonoboea

C. lilacina Ridl.: Weber 860911-1/1 (WU).

Cyrtandra

C. chrysea C. B. Cl. INDONESIA: Borneo, Weber 790922 (WU). *C. clarkei* Stapf. INDONESIA: Borneo, Weber 790924 (WU). *C. cupulata* Ridl.: Weber & Anthonysamy 870519-1/3 (WU). *C. dispar* Dc.: Weber 860818-2/2 (WU). *C. farinosa* C. B. Cl. INDONESIA: Borneo, Weber 790905-1/8 (WU). *C. pendula* Bl.: Weber 870501-1/17 (cult. HBV, WU). *C. pilosa* Bl.: Weber & Anthonysamy 860828-1/4 (WU), 870501-1/16 (WU).

Didissandra

D. frutescens C. B. Cl.: Weber 840803-1/7 (WU). *D. aff. wrayi* Ridl.: Weber & Anthonysamy 870520-1/3 (WU). *D. johorica* Ridl.: Weber 840723-3/2 (WU). *D. morgani* Franch.: Vogel & Weber 790819-2/1 (WU). *D. porphyrantha* R. Kiew & A. Weber: Weber & Anthonysamy 840711-1/3 (WU). *D. quercifolia* Ridl.: Weber 860816-1/1 (WU).

Didymocarpus

D. angustifolius C. B. Cl. INDONESIA: Borneo, Vogel & Weber 790909-1/3 (WU). *D. antirrhinoides* A. Weber: Vogel & Weber 840814-1/4 (WU). *D. bakoensis* B. L. Burtt, INDONESIA: Borneo, Vogel & Weber 790910-1/3 (WU). *D. beccarii* C. B. Cl. INDONESIA: Borneo, Elsener H225 (L). *D. bombycinus* Ridl.: Weber 860819-6/2 (cult. HBV, WU). *D. citrinus* Ridl.: Weber 840802-1/2 (WU). *D. corchorifolius* Wall. ex Dc.: Weber 860810-2/5 (WU). *D. cordatus* Wall. ex Dc. var. *cordatus* Ridl.: Weber 840803-1/8 (WU). *D. cordatus* Wall. ex Dc. var. *debilis* Ridl.: Weber 860811-2/1 (WU). *D. cordatus* Wall. ex Dc. var. *ophirensis* Ridl.: Weber 840718-1/1 (WU). *D. critinus* Jack: Weber 860814-1/3 (cult. HBV, WU). *D. curtisii* Ridl.: Weber 840813-1/1 (WU). *D. flavobrunneus* Ridl.: Weber 860908-1/1 (cult. HBV, WU). *D. aff. floribundus* M. R. Henders.: Vogel & Weber 790813 (WU). *D. glabratus* Ridl.: Weber 840723-1/2 (WU). *D. hirtus* Ridl.: Balgooy 2067 (L). *D. hispidus* Ridl.: Weber 840815-2/3 (WU). *D. koerperi*. INDONESIA: Sumatra; Koerper s.n. (cult. HBV, WU). *D. longipes* C. B. Cl.: Weber 840716-2/2 (WU). *D. malayanus* Hook. f.: Weber 840815-1/1 (WU). *D. aff. malayanus* GS 9/87 (cult. HBV, WU). *Didymocarpus* sp. ined. (Merchang): Weber 870514-2/2 (WU). *D. marginatus* C. B. Cl.: Weber 840717-2/1 (WU). *D. geitleri* A. Weber: Weber 870607-3/1 (cult. HBV, WU). *D. platypus* C. B. Cl.: Weber & Anthonysamy 860826-3/1 (WU). *D. pumilus* Ridl.: Weber 840813-1/2 (WU). *D. puncticulatus* Ridl.: Weber 840722-1/1 (WU). *D. aff. puncticulatus* Ridl.: Weber 870515-3/1 (WU); 870514-4/7 (WU). *D. pyroliflorus* Ridl.: Weber 860823-2/4 (WU); *D. aff. pyroliflorus* Ridl.: Weber & Anthonysamy 870530-1/2 (WU). *D. repens* Bedd. INDIA: Henry 16971 (L). *D. reptans* Jack: Weber 840806-1/3 (WU). *D. rotleriana* Wall. INDIA: Subramanyam 3745 (L). *D. salicinus* Ridl.: Vogel & Weber 790812 (WU). *D. sulphureus* Ridl.: Weber 860820-2/3 (WU). *D. venustus* Ridl.: Weber 860819-2/1 (WU). *D. cf.*

Fig. 5. SEM- and TEM-micrographs of unacetolyzed pollen grains showing exine Type 8 (A-C) and 9 (D-I). A-C. *Ornithoboea flexuosa*. (A) Polar view; SEM. (B) Detail of mesocolpium, note lacking of supratectate elements; SEM. (C) Detail of the aperture; SEM. D. *Didymocarpus pyroliflorus*. Ultrathin section of the exine, showing supratectate elements (arrow), tectum (t), columellae (c) and foot-layer (f); TEM. E-G. *Streptocarpus gardenii*. (E) Oblique polar view; SEM. (F) Detail of mesocolpium; SEM. (G) Side view of conical supratectate elements; SEM. H-I. *Ornithoboea arachnoidea*. (H) Side view of mesocolpium, showing scabrate supratectate elements; SEM. (I) Oblique equatorial view; SEM. - Scale bars: 10 µm (A and I, E), 1 µm (B and F and G and H, C, D).

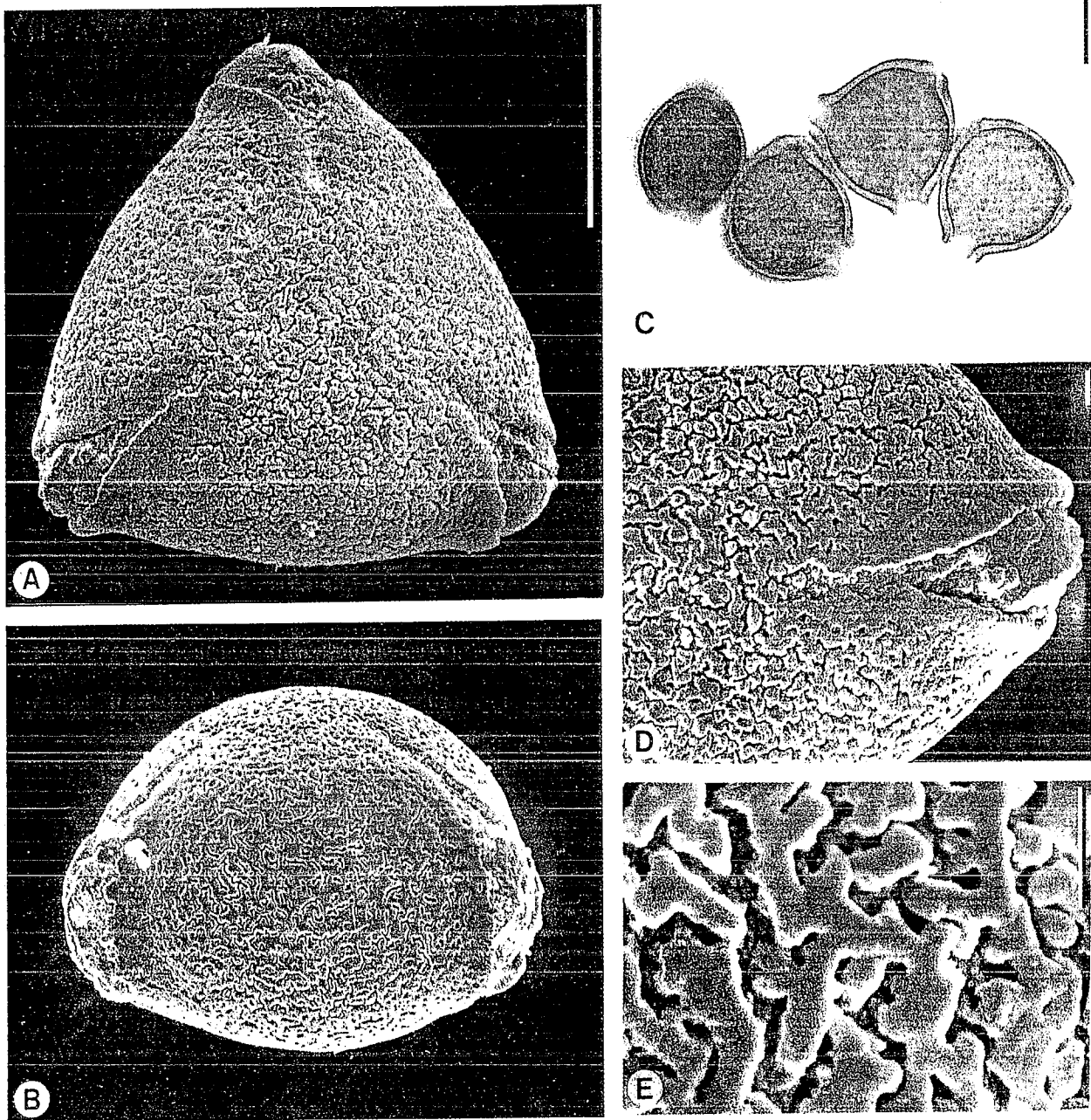


Fig. 6. LM- and SEM-micrographs of unacetolyzed pollen grains of *Epithema membranaceum*, showing exine Type 10. (A) Polar view, note semiangular outline; SEM. (B) Equatorial view; SEM. (C) Pollen grains in polar and equatorial view; LM. (D) Detail of aperture, note smooth colpus membrane; SEM. (E) Detail of mesocolpium; SEM. - Scale bars: 10 μ m (A and B, C, D), 1 μ m (E).

violoides C. B. Cl.: Burt & Woods 2087 (L). *D. zeylanicus* R. Br. CEYLON: Walker 1720 (L).

Epithema

E. membranaceum (King) R. Kiew: Weber 860908-2/1 (cult. HBV, WU); Weber 870508-2/2 (WU); Weber 840807-1/2 (WU). *E. saxatile* Bl.: Weber 860809-1/1 (WU); Weber 860825-1/3 (WU); Weber & Anthonysamy 870521-1/1 (WU).

Loxocarpus

L. coeruleus Ridl.: Weber 860816-1/7 (WU). *L. holttumi* M. R. Henders.: Weber 840723-2/1 (WU). *L. incanus* R. Br.: Weber 840803-1/2 (WU). *L. taeniophyllos* B. L. Burt. BRUNEI: Burt 13263 (L).

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Fig. 7.
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Table I. *Exine types of Gesneriaceae genera examined.*
Arrangement of genera according to supposed relationships. Detailed explanations of exine types are given in the text.

		1-7 = Reticulate, 8-9 = Perforate, 10 = Rugulate									
		1	2	3	4	5	6	7	8	9	10
-	Trichosporaeae										
	<i>Aeschynanthus</i>		*								
-	Didymocarpeae										
	<i>Boea</i>								*	*	
	<i>Paraboea</i>	*						*		*	
	<i>Trisepalum</i>	*									
	<i>Boeica</i>								*		
	<i>Ornithoboea</i>								*	*	
	<i>Didymocarpus</i>	*						*		*	
	<i>Loxocarpus</i>							*		*	
	<i>Codonoboea</i>									*	
	<i>Chirita</i>						*				
	<i>Didissandra</i>	*	*				*				
	<i>Streptocarpus</i>	*				*				*	
-	Klugiaceae (incl. Loxoniaceae)										
	<i>Epithema</i>										*
	<i>Monophyllaea</i>	*									
	<i>Rhynchoglossum</i>	*									
	<i>Loxonia</i>	*									
	<i>Stauranthera</i>			*							
-	Cyrtandreae										
	<i>Cyrtandra</i>	*					*				

Loxonia

L. burttiana A. Weber. INDONESIA: Borneo; Vogel & Weber 790929-2/2 (WU). *L. hirsuta* Jack: Weber 870602-1/5 (WU).

Monophyllaea

M. elongata B. L. Burtt: Weber 860803-2/2 (WU). *M. hirticalyx* Franch.: Weber 860818-1/2 (cult. HBV, WU). *M. horsfieldii* R. Br.: Weber 870518-1/3 (cult. HBV, WU). *M. singularis* (Balf. f. & Smith) B. L. Burtt. INDONESIA: Borneo; Vogel & Weber 790907-1/2 (WU).

Ornithoboea

O. flexuosa (Ridl.) B. L. Burtt: Weber 860810-1/1 (WU). *O. arachnoidea* (Diels) Craib. THAILAND: Puff 871225-1/5 (cult. HBV, WU).

Paraboea

P. bettiana M. R. Henders.: Weber 860825-1/1 (cult. HBV, WU). *P. capitata* Ridl.: GS 14/87 (cult. HBV). *P. elegans* (Ridl.) B. L. Burtt: Weber 840802-1/1 (WU). *P. havilandii* (Ridl.) B. L. Burtt. INDONESIA: Borneo; Weber 790907-1/1 (WU). *P. paniculata* (Ridl.) B. L. Burtt: Weber 790729 (WU).

Rhynchoglossum

R. obliquum Bl. THAILAND: Kurzweil 682 (WU).

Stauranthera

S. grandiflora Benth.: Weber 840726-5/1 (WU).

Streptocarpus

S. caulescens Vatke: u.o., s.n. (cult. HBV). *S. cyaneus* S. Moore: u.o., s.n. (cult. HBV). *S. gardenii* W.J. Hooker



Polar view, of aperture,

holtumii incanus illos B. L.

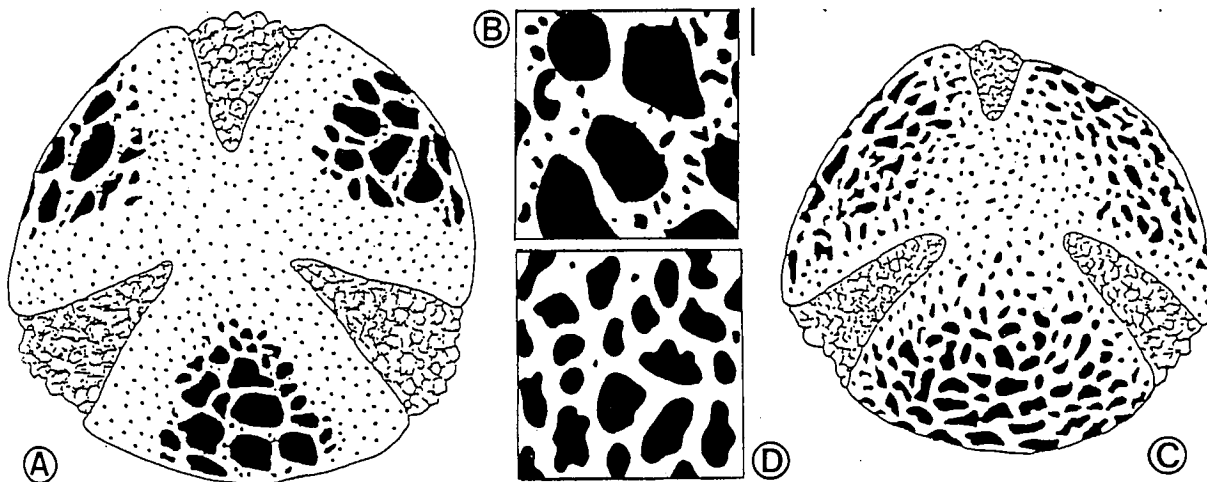


Fig. 7. Schemes of pollen grains, showing heterobrochate exine pattern in the Gesneriaceae. A-B. *Dalbergaria* sp./Gesnerioideae (after Fritze & Williams 1988). (A) Polar view, note abrupt change of lumina size. (B) Detail of heterobrochate mesocolpium. C-D. *Streptocarpus* sp./Cyrtandroideae. (C) Polar view, note continuous change of lumina size. (D) Detail of heterobrochate mesocolpium. - Scale bars: 10 µm (A, C), 1 µm (B, D).

S. AFRICA: HK 1093 (WU). *S. grandis* N. E. Brown: u.o., s.n. (cult. HBV). *S. kirkii* J. D. Hook.: u.o., s.n. (cult. HBV). *S. orientalis* Craib. THAILAND: Puff 871222-2/3 (cult. HBV, WU). *S. primulifolius* Gandoger: u.o., s.n. (cult. HBV). *S. rexii* (Hook.) Lindl. S. AFRICA: Kurzweil 1112 (cult. HBV, WU). *S. saxorum* Engl.: u.o., s.n. (cult. HBV). *S. sylvaticus* Hilliard S. AFRICA: Kurzweil 1089 (cult. HBV, WU).

Trisepalum

T. speciosum (Ridl.) B. L. Burt: Weber 860805-1/1 (WU).

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